Introduction to LUSAS Worked Examples

Where do I start?

Start by reading this introduction in its entirety. It contains useful general information about the LUSAS Modeller user interface and details of how the examples are formatted.

Software requirements

The LUSAS software version, software product (and version of that product) and any product options that are required in order to run an example will be stated in a usage box at the beginning of each worked example, like this:

For LUSAS version:	16.0
For software product(s):	All (except LT versions)
With product option(s):	Nonlinear
The example exceeds the limits of the LUSAS Teaching and Training Version	

Note that Composite examples can be run in any software product if a Composite product option has been purchased. Similarly, LUSAS Analyst or LUSAS Composite products can run bridge or civil examples if a Bridge or Civil product option was purchased. The LUSAS Academic software product will run any example provided the correct product option is selected during start-up.

What software do I have installed?

To find out which software product(s), which version of that product, and which software options are installed and licensed for your use run LUSAS and select **Help > About LUSAS Modeller** and press the **Key Information** button to display a dialog that lists the facilities and options supported by your software license.

About the examples

The examples are of varying complexity and cover different modelling and analysis procedures using LUSAS. The first example in this manual contains detailed information to guide you through the procedures involved in building a LUSAS model, running an analysis and viewing the results. This fully worked example details the contents of each dialog used and the necessary text entry and mouse clicks involved. The remaining examples assume that you have completed the fully worked example and may not necessarily contain the same level of information. It will benefit you to work through as many examples as possible, even if they have no direct bearing on your immediate analysis interests.

Except where mentioned, all examples are written to allow modelling and analysis to be carried out with the Teaching and Training version of LUSAS which has restrictions on problem size. The teaching and training version limits are currently set as follows:

500	100	250	1500	10
Nodes	Points	Elements	Degrees of Freedom	Loadcases

Because of the modelling and analysis limits imposed by the Teaching and Training Versions some examples may contain coarse mesh arrangements that do not necessarily constitute good modelling practice. In these situations these examples should only be used to illustrate the LUSAS modelling methods and analysis procedures involved and should not necessarily be used as examples of how to analyse a particular type of structure in detail.

# Format of the examples

Headings

Each example contains some or all of the following main headings:

❑ **Description** contains a summary of the example, defining geometry, material properties, analysis requirements and results processing requirements.

- **Objectives** states the aims of the analysis.

- **Keywords** contains a list of keywords as an aid to selecting the correct examples to run.
- **Associated Files** contains a list of files held in the \<**Lusas Installation Folder>\Examples\Modeller** directory that are associated with the example. These files are used to re-build models if you have problems, or can be used to quickly build a model to skip to a certain part of an example, for instance, if you are only interested in the results processing stage.

❑ **Modelling** contains procedures for defining the features and attribute datasets to prepare the LUSAS model file. Multiple model files are created in some of the more complex examples and these therefore contain more than one 'Modelling' section.

❑ **Running the Analysis** contains details for running the analysis and assistance should the analysis fails for any reason.

❑ **Viewing the Results** contains procedures for results processing using various methods.

Menu commands

Menu entries to be selected are shown as follows:

Geometry	
Point	>
Coordinates...	
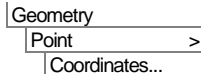
This implies that the **Geometry** menu should be selected from the menu bar, followed by **Point**, followed by the **Coordinates...** option.

Sometimes when a menu entry is referred to in the body text of an example it is written using a bold text style. For example the menu entry shown above would be written as **Geometry > Point > Coordinates...**

Toolbar buttons

For certain commands a toolbar button will also be shown to show the 'short-cut' option to the same command that could be used instead:

The toolbar button for the **Geometry > Point > Coordinates…** command is shown here.

User actions

Actions that you need to carry out are generally bulleted (the exception is when they are immediately to the right of a menu command or a toolbar button) and any text that has to be entered is written in a bold text style as follows:

- Enter coordinates of (**10, 20**).

So the selection of a typical menu command (or the equivalent toolbar button) and the subsequent action to be carried out would appear as follows:

Geometry	
Point	>
Coordinates...	
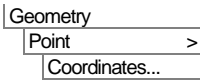
Enter coordinates of (**10, 20**).

Selecting the menu commands, or the toolbar button shown will cause a dialog box to be displayed in which the coordinates **10, 20** should be entered.

Filling-in dialogs

For filling-in dialogs a bold text style is used to indicate the text that must be entered. Items to be selected from drop-down lists or radio buttons that need to be picked also use a bold text style. For example:

- In the New Model dialog enter the filename as **frame_2d** and click the **OK** button to finish.

Grey-boxed text

Grey-boxed text indicates a procedure that only needs to be performed if problems occur with the modelling or analysis of the example. An example follows:

Rebuilding a model
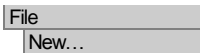
| File | |
| New… | |

Start a new model file. If an existing model is open Modeller will prompt for any un-saved data to be saved before opening the new file.

- Enter the file name as **example**

File	
Script	>
Run Script...	
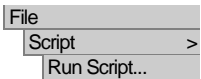
To recreate the model, select the file **example_modelling.vbs** located in the **\<LUSAS Installation Folder>\Examples\Modeller** directory.

Associated Files / Visual Basic Scripts

Each example may reference associated files that should be loaded or run during the course of an example. Thease include files such as model files, spreadsheets, data files as well as Visual Basic script files. These files are supplied on the release kit are installed into the \<**Lusas Installation Folder>\Examples\Modeller** directory.

Updates to these files may occasionally be made between software releases, and if done revised files will be made available for download from the User Area of the LUSAS website.

Model files

Depending upon your access rights it may be necessary to copy a supplied model file to another folder before it can be opened, and remove the read-only protection before it can be saved (by Modeller) to a new folder with the same name.

VBS Files

If results processing and not the actual modelling of an example is only of interest to you the VBS files provided will allow you to quickly build a model for analysis. These scripts are also for use when it proves impossible for you to correct any errors made prior to running an analysis of an example. They allow you to re-create a model from scratch and run an analysis successfully. For more details refer to 'Creating a Model From The Supplied VBS files'.

Modelling Units

At the beginning of each example the modelling units used will be stated something like this:

"Units used are N, m, kg, s, C throughout"

Model units are specified as part of the creation of a new model and are reported at all times in the status bar at the bottom of the Modeller window. Once set, for all dialogs with grid cells permitting dimensional input, the units expected are displayed as a tooltip when the cursor is hovered over the input cell.

Timescale Units

Timescale units are specified as part of the creation of a new model and can be changed on the Model Properties dialog. Choosing a timescale unit dictates how time-based values are displayed on dialogs during modelling, and how they are output when processing results

Icons Used

Throughout the examples, files, notes, tips and warnings icons may be found. They can be seen in the left margin.

Files. The diskette icon is used to indicate files used or created in an example.

Note. A note is information relevant to the current topic that should be drawn to your attention. Notes may cover useful additional information or bring out points requiring additional care in their execution.

☞ **Tip.** A tip is a useful point or technique that will help to make the software easier to use.

⚠ **Caution.** A caution is used to alert you to something that could cause an inadvertent error to be made, or a potential corruption of data, or perhaps give you results that you would not otherwise expect. Cautions are rare, so take heed if they appear in the example.
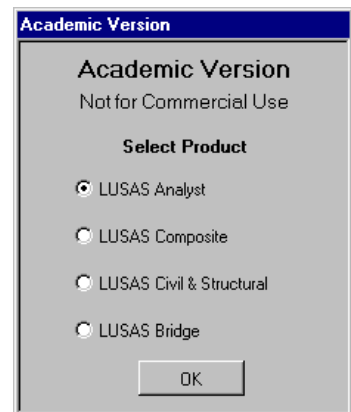
Running LUSAS Modeller

- Start LUSAS Modeller from the start programs menu. This differs according to the operating system in use, but typically is done by selecting:

    'Start' > All Programs > LUSAS 16.0 > LUSAS Modeller

- A licence option will need to be selected in order to allow access to the software.

- The on-line help system will be displayed showing the latest changes to the software.

- Close the on-line Help system window.

(LUSAS Academic version only)

- Select a LUSAS product appropriate for the worked example that is to be carried out, and click the **OK** button.
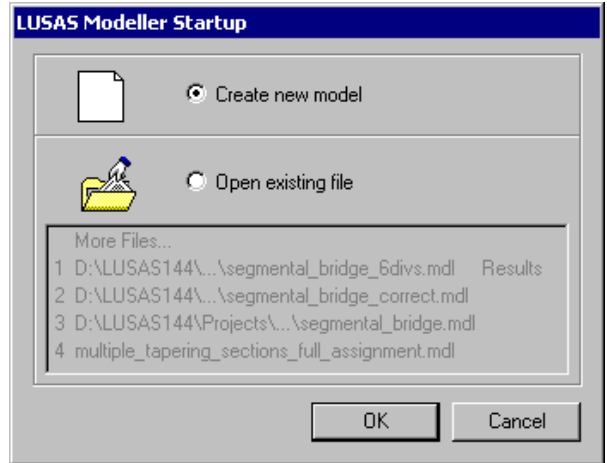
Creating a new model / opening an existing model

When running LUSAS for the first time the LUSAS Modeller Startup dialog will be displayed. This dialog allows either a new model to be created, or an existing model to be opened.

Note. When an existing model is loaded a check is made by LUSAS to see if a results file of the same name exists. If so, you have the option to load the results file on top of the opened model.
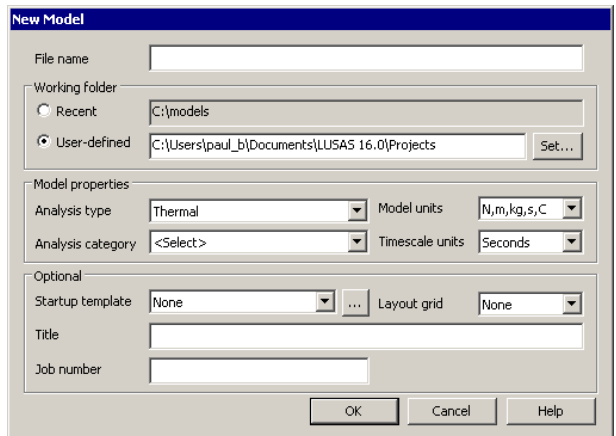
LUSAS Modeller Startup

- ◉ Create new model
- ○ Open existing file

More Files...
1 D:\LUSAS144\...\segmental_bridge_6divs.mdl   Results
2 D:\LUSAS144\...\segmental_bridge_correct.mdl
3 D:\LUSAS144\Projects\...\segmental_bridge.mdl
4 multiple_tapering_sections_full_assignment.mdl

[OK]   [Cancel]

Note. If an existing model is loaded, that in a previous session caused a crash to occur in LUSAS Modeller, options are provided to help you to recover your model data.

If creating a new model the New Model dialog will be displayed.

- Enter information and make selections for the new model and click the OK button.

Product specific menu entries for the selected software product in use e.g. **Bridge** or **Civil** or **Design** will be added to the LUSAS Modeller menu bar.

New Model

File name

Working folder
- ○ Recent   C:\models
- ◉ User-defined   C:\Users\paul_b\Documents\LUSAS 16.0\Projects   [Set...]

Model properties
Analysis type   Thermal
Analysis category   <Select>
Model units   N,m,kg,s,C
Timescale units   Seconds

Optional
Startup template   None   [...]   Layout grid   None
Title
Job number

[OK]   [Cancel]   [Help]

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Saving model files

The worked examples as written do not generally advise you where to save a model, and by default the New Model dialog will initially save files to the <LUSAS Installation Folder>\Projects directory. For the purposes of carrying out the various examples of interest this is acceptable, but note that for real 'live' projects it may be beneficial to save models in separate project folders, each named according to the individual project that will be undertaken. This can assist with backup and eventual deletion of data on a project-by-project basis.

Specifying the saved location of results/intermediate files

The LUSAS Configuration Utility can be used to specify where files created in the course of building a model are saved. See the online help pages for details of how to access this tool. Using this facility, the location of files that are created in the course of a building a model and running the various analyses associated with it can be specified as being:

❑ **Within a folder for each model, within a folder called "Associated Model Data"** This is the default setting. Note that the model file itself does not reside within the folder created.

❑ **Within a folder with the same name as the model** Note that the model file itself does not reside within the folder created.

❑ **Within the same folder as the model** (This was the Version 14.7 behaviour)

❑ **To a specified folder** where the location can be defined by internal LUSAS tokens and ordinary text. For example, the token **%ModelLocn%** is substituted with the working current folder for the model; and **%ModelName%** is substituted with the model's file name. Relative links (e.g. ..\ to use the parent folder) can alternatively be specified.

For the purposes of carrying out the worked examples these settings do not need to be changed.

## Creating a Model from the Supplied VBS Files

If results processing and not the actual modelling of an example is only of interest, the VBS files provided will allow you to quickly build a model for analysis.

Proceed as follows to create the model from the relevant VBS file supplied:
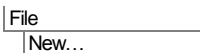
File
New…

Start a new model file.

- Enter the file name as **example name** and click **OK**

File	
Script	>
Run Script...	
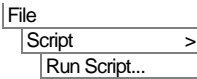
Select the file **example_name_modelling.vbs** located in the **\<LUSAS Installation Folder>\Examples\Modeller** directory, or if you have downloaded, saved and unzipped any associated files for the LUSAS examples from the User Area of the LUSAS website, locate the relevant file on your system and open that instead.
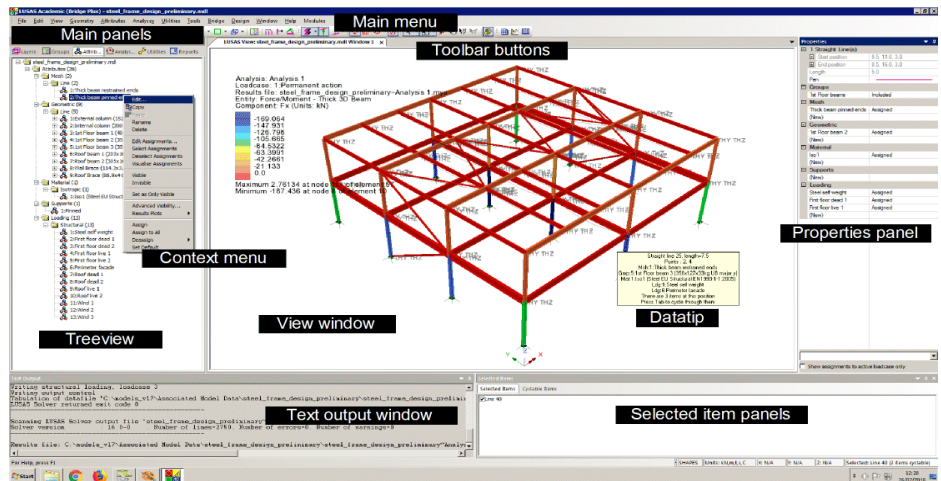
Note. VBS scripts that create models automatically perform a **File > Save** menu command as the end.

Some additional modelling may need to be carried out prior to an analysis being run. See individual examples for details.

The LUSAS Modeller User Interface

The image below shows the principal user interface components of LUSAS Modeller.

View window

❑ A **View Window** shows the model according to user-defined settings made else where on the user interface. Each view window is completely independent and may show the model from a different angle, using different visualization options, with or without results. The image in a view window is built up from several drawing layers as listed in the Layers Treeview (see Main Panels below). Each draws over the top of the one before it.

❑ A **Datatip** provides model-related information about whatever is under the cursor.

❑ A **Tool tip** reports on uses of toolbar buttons or expected input for grid cells in dialogs etc.

Main panels

Each of the main panels has its own **Treeview** showing a list of objects of a particular type. There are panels of Layers, Groups, Attributes, Analyses, Utilities and Reports. Each object in a Treeview has its own functionality. This can be invoked using its own context menu, the main menu or the toolbar buttons. In summary:

❏ The **Layers** Treeview controls the display of model data and results data to a view window. Each drawing layer is responsible for drawing one particluar aspect of this data such as geometry, mesh, and attributes layers for instance.

❏ The **Groups** Treeview is used to store selected user-defined collections of objects (geometry, nodes or elements) under a collective name.

❏ The **Attributes** Treeview is used to store named collections of data that may be attached (assigned) to the model geometry, such as the element type and discretisation on the geometry; section properties and thicknesses; the materials used; how the model is supported or restrained; and how the model is loaded.

❏ The **Analyses** Treeview shows all analyses that have been defined including loadcases, eigenvalues, results, and control chapters. Also in this treeview are post-procressing concepts such as combinations and envelopes.

❏ The **Utilities** Treeview contains utility items used in the definition of model geometry or attributes, or to control an analysis, or to provide a particular functionality, such as to define a load combination or produce a report for example.

❏ The **Reports** Treeview contains a named reports, each of which is made up of multiple chapters. Chapters may be defined to view modelling information, results, screenshots and similar.

Other main panels

Two main panels provide details of properties and associativity for selected objects. The panels are hidden until accessed by a selecting a feature/object and choosing the relevant context menu item for that feature/object. They can also be made visible by selecting the **View > Main Panels** menu item. The panels can be docked, and separate tabs are provided for each panel when done. Double-clicking a docked window will isolate it again. The panels are:

❏ **Properties** - displays the current properties of selected geometry features (points, lines, surface, volumes) and selected mesh objects (nodes, edges, elements, faces). See **Properties Panel** for more information.

❏ **Hierarchy** - shows the **merge** status, and lists the higher and lower order features/objects of a single selected geometry feature or mesh object. The type and feature number of the selected feature is shown.

Context menus

❑ A **Context menu** (displayed by pressing the right-hand mouse button with an object selected) provides access to additional functionality such as editing of data, control of visibility, visualisation of assignments, and selective control of results plotting on selected attributes. Context menus are provided for objects selected in the View Window, and most items in the various Treeview panels.

Selection Panels

❑ **Selected Items** This panel can be viewed using the View> Selection Panels > Selection menu item. Once visible it will contain a list of all currently selected items which may then be individually deselected.

❑ **Selection Memory** This panel can be viewed using the View> Selection Panels > Memory menu item. Once visible it will contain a list of all items currently in Selection Memory which may then be individually deselected.

❑ **Cyclable Items** This panel can be viewed using the View> Selection Panels > Cyclable Items menu item. Once visible it will contain a list of all cyclable items. Where multiple items could possibly be selected by the same mouse click, cycling is the process of stepping through those items one at a time. An item can then be individually selected or deselected.

❑ **Visible items** This panel can be viewed using the View> Selection Panels > Visible Items menu item. Once opened it contains details of all visible items selected in the view window.

Text Output Window

❑ The **Text Output Window** provides continuous feedback during a modelling or analysis process, and includes errors, warnings and progress messages. When an error message or warning relating to a particular object is written to the text output window, extra information is sometimes available by double-clicking on that line of text.

Status bar

❑ The **Status Bar** displays progress messages and help text during a modelling session, the model units, the current cursor position in model units (if the model is displayed in an orthogonal plane) and the item or number of items in the current selection. A view of the model can be obtained by pressing one of the primary axes shown in the status bar.

General notes

Within each View window, and within each Treeview, there is a current selection. In a Treeview there can only be one object selected at a time, and all commands are assumed to apply to it. In a View window several objects can be selected at the same time. Main menu and toolbar commands apply to whichever window was most recently clicked, either a View window or a Treeview panel.

Some items within a Treeview support drag and drop functionality. Typically this will move them, copy them or connect them together. For example, dragging an attribute from the Treeview onto a View window assigns the selected attribute to the selected object in that window.

All the menus, toolbars, tree frame, text window, status bar and other similar windows can be resized, moved, made visible or invisible, and docked or separated from the main program window. LUSAS Modeller will remember their new location for the next time the program is run. Additional customization is possible - see the *Modeller Reference Manual* for details.

Getting Help

LUSAS contains a comprehensive Help system. The Help consists of the following:

- Most dialogs include a **Help** button which provides information on that dialog.

- Selecting **Help > Help Topics** from the main menu provides access to all the Help files.

 If the Help Contents, the Help Index and the Search facility are not shown when a help page is first displayed pressing the Show button will show these tabs in the HTML Help Window.